DEFENSE HEALTH BOARD
7700 ARLINGTON BOULEVARD, SUITE 5101
FALLS CHURCH, VA 22042-5101

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FOR: JONATHAN WOODSON, M.D., ASSISTANT SECRETARY OF DEFENSE (HEALTH AFFAIRS)

SUBJECT: Supraglottic Airway Use in Tactical Evacuation Care 2012-06

EXECUTIVE SUMMARY

The Tactical Combat Casualty Care (TCCC) Guidelines for Tactical Evacuation (TACEVAC) Care outline stepped airway management interventions for a casualty with airway obstruction or impending airway obstruction. These include the chin lift/jaw thrust maneuver, nasopharyngeal airway and recovery position as first-line interventions. Should these prove unsuccessful, the Guidelines recommend the laryngeal mask airway (LMA) or Combitube™ (Combitube) device for supraglottic airway (SGA) interventions, endotracheal intubation or surgical cricothyroidotomy. Many new SGA devices have emerged since the development of the TCCC Guidelines. Evidence is inconclusive as to whether any one device is superior over another. Patient safety and provider competency literature suggests that provider experience may be a better indicator of safety and efficacy than individual device capabilities. Therefore, the Defense Health Board (DHB) recommends that the specific devices referenced in the TCCC Guidelines for SGA interventions during TACEVAC Care be removed.

INTRODUCTION

Charge

The TCCC Guidelines are a set of trauma care instructions customized for use on the battlefield during tactical field care and TACEVAC (**Attachment A**). The Committee on TCCC (CoTCCC), a Work Group of the DHB Trauma and Injury Subcommittee, performs a quarterly review of current evidence, emerging data and feedback from the field to ensure the TCCC Guidelines reflect evolving best practices.

The TCCC Guidelines provide a spectrum of airway management interventions for a casualty with airway obstruction or impending airway obstruction during TACEVAC. These include the chin lift/jaw thrust maneuver, nasopharyngeal airway and recovery position as first-line interventions, as well as the LMA and Combitube for SGA interventions, endotracheal intubation or surgical cricothyroidotomy, should the first-line approaches prove unsuccessful. In an effort to optimize appropriate use of the SGA and in light of various new SGA devices emerging on the market, the SGA component of this spectrum is being updated.

Methodology

Dr. Mel Otten, Trauma and Injury Subcommittee member, conducted a comprehensive literature review of airway management best practices. Using available evidence, Dr. Otten and Subcommittee member Dr. Frank Butler developed a white paper proposing that the CoTCCC revise the TCCC Guidelines for TACEVAC to allow the use of other SGA devices in addition to

the LMA and Combitube. Dr. Otten presented the proposed revision at the May 2012 CoTCCC meeting, during which the CoTCCC deliberated the findings and unanimously agreed to forward it to the Trauma and Injury Subcommittee. The Subcommittee subsequently approved the recommended revision during its meeting and forwarded it to the Board for consideration. The Board conducted a comprehensive literature review which included an evaluation of levels of evidence in accordance with the Oxford Centre for Evidence-Based Medicine method[1] (**Attachment B**). Board members approved this revision, in the form of a recommendation, at the June 2012 meeting. While finalizing the recommendation to the Department, Dr. Dickey proposed text be added to encourage the Services to select a limited number of devices, emphasize the importance of training and to work toward standardization. Additionally, she recommended text regarding ongoing research and identification of best practices. In August 2012, the Board members agreed with Dr. Dickey's comments and changes, and approved the revised recommendation by unanimous vote.

EVIDENCE

Recently, many new SGA devices have emerged in an effort to optimize airway devices,[2,3,4] and additional generations may be expected. Although current evidence does not support one device as being superior over another,[5,6,7] patient safety and provider competency literature document that a device is likely to outperform others when utilized by a provider with more experience and training in using that device. Specifically, provider experience and skill strongly influence the effectiveness, efficiency and safety of devices and procedures.[8,9,10,11,12,13,14,15] Those performed by more experienced and adequately trained providers are less likely to result in adverse events, including injuries resulting from device misuse or unfamiliarity. Expert feedback from the field from post-mortem examinations further underline the importance of ensuring SGA devices are used properly. These data suggest that providers should be trained specifically on the devices they would use in theater in order to enhance both Service member safety and treatment success.

Practice effects may also compel providers to develop strong device preferences.[15] Industry surveys and academic reviews highlight relationships between provider training and experience with device preference, selection, familiarity and perceived quality.[15,16,17,18] Training greatly influences device selection, as physicians are more likely to use devices on which they are trained,[17] particularly if recent.[15] Providers hesitate to switch devices primarily because of the speed and proficiency attained in using those familiar to them.[16]

Since national standards and criteria are lacking for determining when new products should be deployed to replace existing ones,[19] determining which devices should be fielded should take into account various logistical and practical considerations, including differences across the military Services. These include acquisition and procurement processes as well as equipping and fielding in theater.

SGA device selection is specific to each military Service. For example, the U.S. Army is currently using the King LT™ (King LT) rather than the Combitube in combat medic training and equipping.[20,21] The U.S. Army started training medics to use the King LT, since it was demonstrated to be faster and more easily inserted than the Combitube in prospective observational studies[22,23] examining their use by combat medics in training.[21] As multiple types

of airway devices are being fielded, training and continued research on the optimal airway device are critical.[21] In addition, challenges associated with the combat environment should be taken into consideration when evaluating device performance, as the environment in which the device is used impacts its safety and usability.[24]

Provider type, supply options and available resources may also contribute to which airway device is used.[21] A prospective observational study examining casualties presenting at combat support hospitals found that medics used the greatest variety of airway devices among all providers.[21] The study also underlined that individuals are provided some degree of autonomy in selecting preferred airway devices, noting that in the combat setting, medical guidance in far-forward Army units lacks standardization, while training can be highly variable across units and individuals.[21,25,26] Resources are typically limited for units that are further far-forward, constraining the types of devices available to providers in this setting.[21]

Other logistical and practical considerations should take into account differences in battlefield trauma care equipment procurement processes across the military Services. Cost-containment strategies pursued by civilian health care facilities underline benefits associated with standardizing medical devices. These include restricting the number of available device options by limiting the number of vendors, as well as negotiating lower prices and price ceilings.[19] If current evidence does not support one device as being superior over another, then cost considerations alone indicate that one or two devices should be kept in the equipment inventory, and used in provider training and equipping. However, potential cost-containment practices such as purchasing large volumes of equipment to meet Service needs for several years, may introduce challenges resulting from the rapid, continuous evolution of medical best practices. As equipment investments by each military Service are significant, timely and adequate prehospital data collection, dissemination and analyses are critical in helping inform these expenditures.

LIMITATIONS

Although there are several studies of airway management devices and techniques, the current evidence base primarily consists of studies done in a controlled hospital environment (under anesthesia during elective surgery), on manikins, cadavers or in the civilian prehospital environment. The generalizability of these studies to the battlefield is limited, and the effectiveness of SGA devices in patients with direct airway trauma is not well studied.[5] SGA device insertion and ventilation studies frequently lack the power required to examine survival rates.[6,27] These studies are largely descriptive/observational or retrospective, providing primarily Level III and Level IV evidence based on the Oxford Centre for Evidence-Based Medicine grading scale.

Varying levels of provider training and experience across studies makes it difficult to compare outcomes. Industry and academic literature examining provider selection and preference for medical devices are often based on provider survey data (primarily Level III evidence). These reports demonstrate a positive correlation between device efficacy and safety, provider preference and familiarity. Retrospective studies of device-related injuries and patient safety using hospital and clinic records generally yield Level III evidence. Randomized controlled trials (where feasible) and comparable pilot studies are needed to compare SGA devices, airway

management techniques and device effectiveness. Data collection forums, such as the Joint Theater Trauma Registry and other unit-based trauma registries, are imperative to enhancing outcomes-based research on optimal airway devices and techniques.

DELIBERATIONS

Members discussed implications pertaining to recommending the use of unlimited rather than a discrete number of SGA devices, until the evidence demonstrates that a particular device is superior. The Board considered issues pertaining to patient safety; potential adverse events; training and equipment standardization across the military Services; battlefield procurement processes; and prehospital data collection. In addition, members discussed potential benefits associated with limiting the number of SGA devices recommended in the TCCC Guidelines. These included enabling better use of training, as well as enhancing patient safety and treatment effectiveness, in allowing providers to acquire experience and proficiency by repeatedly using a specific device. However, members recognized that the current evidence base does not support the use of one SGA device over another, and that the collection and continuous evaluation of adequate prehospital data are necessary to identify an optimal device and develop evidence-based recommendations for its use. Although equipment standardization across the military Services is a desirable objective, the members understood that training plays a critical role in the near term when determinations are made regarding which SGA device would be best for use. Specifically, provider training and proficiency affect the likelihood that a device might fail, due to user error, or cause unintended adverse effects and patient harm. This is particularly critical, since training and proficiency levels vary across provider types and across the military Services.

In addition, the Board concluded: any recommendations advocating a specific SGA device be based on the best available evidence demonstrating its superiority; absent this evidence, the military Services should enhance the safety of Service members by selecting a limited number of devices and ensuring that the inventory, training and equipping practices are aligned and consistent with the devices selected; provider training be appropriate and realistic, and ensure the sustainment of acquired skills and proficiencies; SGA devices be evaluated on an ongoing basis, as new data emerge and recently developed devices are further tested; continued research and adequate prehospital data collection be ensured as they are vital for identifying best practices; and equipment inventories, as well as provider training and equipping, eventually be standardized across the military Services. Current initiatives to standardize training, such as the Tri-Service training provided for enlisted medical personnel at the Medical Education and Training Campus at Fort Sam Houston, Texas, may also serve as an impetus for the military Services to adopt a common equipment inventory and fielding practice in theater.

The Board also cautioned that inventory practices should account for the rapid, continuous evolution of medical best practices, where feasible. This would facilitate a timely adoption and fielding of optimal devices consistent with the best available scientific evidence. Based on emerging patient safety data, the Board noted that the issue of ensuring consistency regarding SGA device use across inventory, training and equipping practices may also be pertinent to other equipment fielded in theater.

CONCLUSION

Considering the evidence and its limitations, the Board concludes that there is no strong evidence to support the use of one SGA device over another.

RECOMMENDATIONS

The DHB recommends that:

1. The specific devices referenced in the TCCC Guidelines for SGA interventions during TACEVAC Care be removed.

2. Recommendations advocating a specific SGA device be based on the best available evidence demonstrating its superiority. Should such a device emerge, the military Services should ensure providers are trained on its use and are equipped to field it in theater.

3. Absent evidence indicating one device is superior over another, the military Services should enhance the safety of Service members by selecting a limited number of devices and ensuring that the inventory, training and equipping practices are aligned and consistent with the devices selected. Provider training should be appropriate and realistic, and should ensure the sustainment of acquired skills and proficiencies.

4. SGA devices be evaluated on an ongoing basis as new data emerge and recently developed devices are further tested.

5. Continued research and adequate prehospital data collection be ensured as they are vital for identifying best practices.

6. Equipment inventories, as well as provider training and equipping, eventually be standardized across the military Services. Current initiatives to standardize training, such as the Tri-Service training provided for enlisted medical personnel at the Medical Education and Training Campus at Fort Sam Houston, Texas, may also serve as an impetus for the military Services to adopt a common equipment inventory and fielding practice in theater.

7. Inventory practices should account for the rapid, continuous evolution of medical best practices, where feasible. This would facilitate a timely adoption and fielding of optimal devices based on the best available scientific evidence. Emerging patient safety data indicate that the issue of ensuring consistency regarding SGA device use across inventory, training and equipping practices may also be pertinent to other equipment fielded in theater.

In addition, the DHB recommends the Department incorporate the following proposed change (in **bold**) in the TCCC Guidelines for airway management during TACEVAC:

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Tactical Evacuation Care

1. Airway Management
    a. Unconscious casualty without airway obstruction:
        - Chin lift or jaw thrust maneuver
        - Nasopharyngeal airway
        - Place casualty in the recovery position
    b. Casualty with airway obstruction or impending airway obstruction:
        - Chin lift or jaw thrust maneuver
        - Nasopharyngeal airway
        - Allow casualty to assume any position that best protects the airway, to include sitting up.
        - Place unconscious casualty in the recovery position.
        - If above measures unsuccessful:
            - **Supraglottic airway** or
            - Endotracheal intubation or
            - Surgical cricothyroidotomy (with lidocaine if conscious).
    c. Spinal immobilization is not necessary for casualties with penetrating trauma.

FOR THE DEFENSE HEALTH BOARD:

Nancy W. Dickey MD

Nancy Dickey, M.D.
DHB President

ATTACHMENTS:

A. TCCC Guidelines
B. Oxford Centre for Evidence Based Medicine Levels of Evidence Table

WORKS CITED

1. OCEBM Levels of Evidence Working Group. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. Available at: http://www.cebm.net/index.aspx?o=5653. Accessed on May 22, 2012.

2. Joliffe L, and I Jackson (2008) Airway management in the outpatient setting: new devices and techniques. *Current Opinion in Anaesthesiology* **21:**719-722.

3. Hernandez MR, Klock PA, Ovassapian A (2012) Evolution of the extraglottic airway: a review of its history, applications, and practical tips for success. *Anesthesia & Analgesia* **114:**349-368.

4. Erlacher W, Tiefenbrunner H, Kästenbauer T, et al (2011) CobraPLUS and Cookgas air-Q versus Fastrach for blind endotracheal intubation: a randomized controlled trial. *European Journal of Anaesthesiology* **28:**181-186.

5. Timmerman A (2011) Supraglottic airways in difficult airway management: successes, failures, use and misuse. *Anaesthesia* **66**(Suppl. 2):45-56.

6. American Heart Association (2001) International Liaison Committee on Resuscitation (ILCOR). Proceedings of the guidelines 2000 conference for cardiopulmonary resuscitation and emergency cardiovascular care: an international consensus on science. *Annals of Emergency Medicine* **37**(Suppl. 4):S1—S200.

7. Hooshangi H and D Wong (2008) Brief review: the Cobra Perilaryngeal Airway (CobraPLA and the Streamlined Liner of Pharyngeal Airway (SLIPA) supraglottic airway. *Canadian Journal of Anesthesia* **55:**177-185.

8. Barker FG, Amin-Hanjani S, Butler WE et al(2003) In-hospital mortality and morbidity after surgical treatment of unruptured intracranial aneurysms in the United States, 1996-2000:the effect of hospital and surgeon volume. *Neurosurgery* **52:**995-1009.

9. Crowley JJ and RD Kaye (2002) Identifying and understanding medical device use errors. *Journal of Clinical Engineering* **42:**188-193.

10. Hijazi R (2011) The impact of medical devices on patient health: an analysis of patient safety and risk. *Journal of Clinical Engineering* **36:**105-108.

11. Riscucci D, Geiss A, Gellman L et al (2001) Surgeon-specific factors in the acquisition of laproscopic surgical skills. *American Journal of Surgery* **181:**289-293.

12. Risucci D, Geiss A, Gellman L et al (2000) Experience and visual perception in resident acquisition of laparoscopic skills. *Current Surgery* **57:**368-372.

13. Rosser JC, Rosser L, Savalgi R (1998) Objective evaluation of a laparoscopic surgical skill program for residents and senior surgeons. *Archives of Surgery* **133:**657-661.

14. Rosser JC, Rosser L, Savalgi R (1997) Skill acquisition and assessment for laparoscopic surgery. *Archives of Surgery* **132:**200-204.

15. Scannell J and L Bendell (2008) *Orthopaedics: surgeon switching, loyalty, and patterns of product use. Part 1 of detailed survey results*. New York: Sanford Bernstein & Co.

16. Burns LR, Houseman MG, Booth RE, et al (2009) Implant vendors and hospitals: competing influences over product choice by orthopedic surgeons. *Health Care Management Review* **34**:2-18.

17. DeGraff RA and MV Pauly (2002) Medical device vendors. In L.R. Burns, & Wharton School Colleagues (Eds.), *The health care value chain* (pp. 243-293). San Francisco: Jossey-Bass.

18. Wilson NA, Schneller ES, Montgomery K et al (2008) Hip and knee implants: current trends and policy considerations. *Health Affairs* **27:**1587-1598.

19. Montgomery K and ES Schneller (2007) Hospitals' strategies for orchestrating selection of physician preference items. *Milbank Quarterly* **85:**307-335.

20. Center for Army Lessons Learned. Tactical Combat Casualty Care Handbook: Observations, Insights and Lessons. No. 12-10. March 2012.

21. Adams BD, Cuniowski PA, Muck A et al (2008) Registry of emergency airways arriving at combat hospitals. *Journal of Trauma* **64:**1548-1554.

22. McManus JG, Parsons D, Proulx CA, et al (2005) 2005 SAEM Annual Meeting abstracts: Combat trauma airway management: combitube versus the king laryngeal tracheal device by army combat medic students. *Academic Emergency Medicine* **12**:162.

23. McManus JG, Hill G, Arkava T, et al (2005) 2005 SAEM Annual Meeting abstracts: Combitube dual-lumen esophageal airway device retention skills in deployed army combat medics. *Academic Emergency Medicine* **12**:162-a.

24. Shojania KG, Duncan BW, McDonald KM, et al., eds. *Making Health Care Safer: A Critical Analysis of Patient Safety Practices. Evidence Report/Technology Assessment No. 43.* (Prepared by the University of California at San Francisco–Stanford Evidence-based Practice Center under Contract No. 290-97-0013), AHRQ Publication No. 01-E058, Rockville, MD: Agency for Healthcare Research and Quality. July 2001.

25. DeLorenzo RA (2005) How shall we train? *Military Medicine* **170:**824-830.

26. DeLorenzo RA (2001) Medic for the millenium: the U.S. Army 91W health care specialist. *Military Medicine* **166:**685-688.

27. Nolan JP, Soar J, Zideman DA et al (2010) European Resuscitation Council Guidelines for Resuscitation 2010. *Resuscitation* **81**:1219-1276.

Guthrie M, Froneberger PM, Terry D (2005) *Better performers in cardiovascular care* Charlotte, NC: Premier. (Pending receipt from library)

Miksic M, Reicin G, Yik A et al (2005) *Hospital supplies and medical technology:2005 orthopaedic survey.* New York: Morgan Stanley. (Not available)

ADDITIONAL REFERENCES

2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Part 4: Advanced Life Support. *Circulation* **112:**III-25-III-54.

Akca O, Wadhwa A, Sengupta P, et al (2004) The new perilaryngeal airway (Cobra PLA) is as efficient as the laryngeal mask airway (LMA) but provides better airway sealing pressures. *Anesthesia & Analgesia* **99:**272–278.

Alexander R, Hodgson P, Lomax D, et al (1993) A comparison of the laryngeal mask airway and Guedel airway and face mask for manual ventilation following formal training. *Anaesthesia* **48**:231-234.

American Heart Association (2001) International Liaison Committee on Resuscitation (ILCOR). Proceedings of the guidelines 2000 conference for cardiopulmonary resuscitation and emergency cardiovascular care: an international consensus on science. *Annals of Emergency Medicine* **37**(Suppl. 4):S1—S200.

Barker P, Langton JA, Murphy PJ et al (1992) Regurgitation of gastric contents during general anesthesia using the laryngeal mask airway. *British Journal of Anesthesia* **69:**314-315.

Bledsoe B and W Gandy (2009) The Disappearing Endotracheal Tube: Historic skill threatened by lack of practice and new devices. *Journal of Emergency Medical Services* **34:**88-99.

Burns JB, Branson R, Barnes SL, et al (2010) Emergency airway placement by EMS providers: comparison between the King LT supralaryngeal airway and endotracheal intubation. *Prehospital and Disaster Medicine* **25:**92-95.

Burns LR, Lee JA, Bradlow ET et al (2007) Surgeon evaluation of suture and endo-mechanical products. *Journal of Surgical Research* **141:**220-233.

Burns LR, Nash D and D Wholey (2007) The evolving role of third parties in the hospital-physician relationship. *American Journal of Medical Quality* **22:**402-409.

Butler FK Jr, Giebner SD, McSwain N, et al, eds. Prehospital Trauma Life Support Manual, Military Edition. 7th ed. Philadelphia: Mosby/Journal of Emergency Medical Services, 2010. Print.

Butler FK, Haymann J, Butler G (1996) Tactical Combat Casualty Care in Special Operations. *Military Medicine* **161(**Suppl. 3):3-16.

Cady C, Weaver M, Pirrallo R, Wang H (2009) Effect of emergency medical technician-places Combitubes on outcomes after out-of-hospital cardiopulmonary arrest. *Prehospital Emergency Care* **13:**495-499.

Castle N, Pillay Y, Spencer N (2011) Insertion of six different supraglottic airway devices whilst wearing chemical, biological, radiation, nuclear-personal protective equipment: a manikin study. *Anaesthesia* **66:**983-988.

Cobas M, De la Peña M, Manning R et al (2009) Prehospital intubations and mortality: a level 1 trauma center perspective. *Anesthesia & Analgesia* **109:**489-493.

Cook TM and C Hommers (2006) New airways for resuscitation? *Resuscitation* **69**:371-387.

Darlong V, Chandrashish C, Chandralekha VKM (2011) Comparison of the performance of 'Intubating LMA' and 'Cobra PLA' as an aid to blind endotracheal tube insertion in patients scheduled for elective surgery under general anesthesia. *Acta Anaesthesiologica Taiwanica* **49:**7-11.

Davies PR, Tighe SQM, Greenslade GL et al (1990) Laryngeal mask airway and tracheal tube insertion by unskilled personnel. *Lancet* **336:**977-979.

Deakin CD (1996) Prehospital management of the traumatized airway. *European Journal of Emergency Medicine* **3:**233-243.

Denver Metro Airway Study Group (2009) A prospective multicenter evaluation of prehospital airway management performance in a large metropolitan region. *Prehospital Emergency Care* **13:**304-310.

Eastridge BJ, Mabry RL, Blackbourne LH and Butler FK (2011) We Don't Know What We Don't Know: Prehospital Data in Combat Casualty Care. *The United States Army Medical Department Journal* **April-June:**11-14.

Gahan K, Studnek JR, Vandeventer S (2011) King LT-D use by urban basic life support first responders as the primary airway device for out-of-hospital cardiac arrest. *Resuscitation* **82:**1525-1528.

Gaitini L, Yanovski B, Somri M et al (2006) A comparison between the PLA Cobra™ and the Laryngeal Mask Airway Unique™ during spontaneous ventilation: a randomized prospective study. *Anesthesia & Analgesia* **102:**631–6.

Gaitini LA, Somri MJ, Kersh K, et al (2003) A comparison of the Laryngeal Mask Airway Unique™, Pharyngeal Airway X press™ and Perilaryngeal Airway Cobra™ in paralyzed anesthetized adult patients. *Anaesthesiology* **99:**A1495 (abstract).

Gatward JJ, Thomas MJC, Nolan JP et al (2008) Effect of chest compressions on the time taken to inset airway devices in a manikin. *British Journal of Anaesthesia* **100:**351-356.

Gibbison B, Cook TM, Seller C (2008) Case series: protection from aspiration and failure of protection from aspiration with the i-gel airway. *British Journal of Anaesthesia* **100:**415-417.

Grayling M, Wilson IH, Thomas B (2002) The use of the laryngeal mask airway and Combitube® in cardiopulmonary resuscitation: a national survey. *Resuscitation* **52:**183-186.

Howes BW, Wharton NM, Gibbison B et al (2010) LMA Supreme™ insertion by novices in manikins and patients. *Anaesthesia* **65:**343-347.

Hubble MW, Wilfong DA, Brown LH, et al (2010) A meta-analysis of prehospital airway control techniques part II: alternative airway devices and cricothyrotomy success rates. *Prehospital Emergency Care* **14:**515-530.

International Guidelines 2000 for CPR and ECC——a consensus on science. Part 6: advanced cardiovascular life support, Section 3: adjuncts for oxygenation, ventilation, and airway control. *Resuscitation* **46:**115-125.

Joffe AM. Liew EC, Galgon RE, et al (2011) The second-generation air-Q® intubating laryngeal mask for airway maintenance during anesthesia in adults: a report of the first 70 uses. *Anaesthesia and Intensive Care* **39:**40-45.

Kajino K, Iwami T, Kitamura T, et al (2011) Comparison of supraglottic airway versus endotracheal intubation for the pre-hospital treatment of out-of-hospital cardiac arrest. *Critical Care* **15:**R236.

Keller C, Brimacombe J, Bittersohl J et al (2004) Aspiration and the laryngeal mask airway: three cases and a review of the literature. *British Journal of Anaesthesia* **93:**579-582.

Khaja SF, Provenzano MJ, Chang KE (2010) Use of the King LT for emergency airway management. *Archives of Otolaryngology Head and Neck Surgery* **136:**979-982.

Klaver NS, Kuizenga K, Ballast A et al (2007) A comparison of the clinical use of the Laryngeal Tube S™ and the ProSeal® Laryngeal Mask Airway by first-month anaesthesia residents in anaesthetized patients. *Anaesthesia* **62:**723-727.

Koehli N (1991) Aspiration and the laryngeal mask airway (letter). *Anaesthesia* **46:**419.

Kurola J, Pere P, Neimi-Murola L et al (2006) Comparison of airway management with the intubating laryngeal mask, laryngeal tube and CobraPLA® by paramedical students in anaesthetized patients. *Acta Anaesthesiologica Scandinavica* **50:**40–44.

Lecky F, Bryden D, Little R et al (2009) Emergency intubation for acutely ill and injured patients (review). The Cochrane Collaboration.

Lefrancois DP and DG Dufour (2002) Use of the esophageal tracheal Combitube™ by basic emergency medical technicians. *Resuscitation* **52:**77– 83.

Mabry RL and A Frankfurt (2012) An analysis of battlefield cricothyrotomy in Iraq and Afghanistan. *Journal of Special Operations Medicine* **12:**17-23.

Macdonald JC and HCN Tien (2008) Emergency battlefield cricothyrotomy. *Canadian Medical Association Journal* ***178:***1133-1135.

Miller DM and D Light (2003) Storage capacities of the laryngeal mask and the laryngeal tube compared and their relevance to aspiration risk during positive pressure ventilation. *Anesthesia & Analgesia* **96:**1821-1822.

Nolan JP, Deakin CD, Soar J et al (2005) European Resuscitation Council Guidelines for Resuscitation 2005. Section 4. Adult advanced life support. *Resuscitation* **67**(Suppl. 1):S39-S86.

Nolan JP (2001) Prehospital and Resuscitative Airway Care: Should the Gold Standard be Reassessed? *Current Opinion in Critical Care* **7:**413-421.

Ochs M, Vilke GM, Chan TC et al (2000) Successful prehospital airway management by EMT-Ds using the Combitube. *Prehospital Emergency Care* **4:**333–337.

Pennant JH and MB Walker (1992) Comparison of the endotracheal tube and laryngeal mask in airway management by paramedical personnel. *Anesthesia & Analgesia* **74:**531-4.

Rabitsch W, Schellongowski P, Staudinger T et al (2003) Comparison of a conventional tracheal airway with the Combitube in an urban emergency medical services system run by physicians. *Resuscitation* **57:**27–32.

Ragazzi R, Finessi L, Farinelli I et al (2012) LMA Supreme™ vs I-Gel™ – a comparison of insertion success. *Anaesthesia* **67:**384-388.

Reinhardt DJ and G Simmons (1994) Comparison of placement of the laryngeal mask airway with endotracheal tube by paramedics and respiratory therapists. *Annals of Emergency Medicine* **24:**260-263.

Rich JM, Mason A, Bey T et al (2004) The critical airway, rescue ventilation and the Combitube: Part 1. *American Association of Nurse Anesthetists* **72:**17-27.

Rich JM, Mason AM, Bey TA et al (2004) The critical airway, rescue ventilation and the Combitube: Part 2. *American Association of Nurse Anesthetists* **72**:115-124.

Rich JM, Mason AM, Tillmann Hein HA, et al (2009) Rescue ventilation: resolving a "cannot mask ventilate, cannot intubate" situation during exchange of a Combitube for a definitive airway. *American Association of Nurse Anesthetists* **77:**339-342.

Richards CF (1998) Piriform sinus perforation during esophageal-tracheal Combitube placement. *Journal of Emergency Medicine* **16:**37–39.

Ridgway S, Hodzovic I, Woollard M et al (2004) Prehospital airway management in ambulance services in the United Kingdom. *Anaesthesia* **59:**1091-1094.

Ruetzler K, Gruber C, Nabecker S, et al (2011) Hands-off time during insertion of six airway devices during cardiopulmonary resuscitation: a randomized manikin trial. *Resuscitation* **82:**1060-1063.

Rumball C, Macdonald D, Barber P et al (2004) Endotracheal intubation and esophageal tracheal Combitube insertion by regular ambulance attendants: a comparative trial. *Prehospital Emergency Care* **8:**15–22.

Rumball CJ, and D MacDonald (1997) The PTL, Combitube, laryngeal mask, and oral airway: a randomized prehospital comparative study of ventilator device effectiveness and cost-effectiveness in 470 cases of cardiorespiratory arrest. *Prehospital Emergency Care* **1:**1–10.

Russi CS, Hartley MJ, Buresh CT (2008) A pilot study of the King LT supralaryngeal airway use in a rural Iowa EMS system. *International Journal of Emergency Medicine* **1:**135-138.

Russi CS, Miller L, Hartley MJ (2008) A comparison of the King-LT to endotracheal intubation and Combitube in a simulated difficult airway. *Prehospital Emergency Care* **12:**35-41.

Schälte G, Stoppe C, Aktas M, et al (2011) Laypersons can successfully place supraglottic airways with 3 minutes of training. A comparison of four different devices in the manikin. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* **19:**60-67.

Schmidbauer W, Bercker S, Volk T, et al (2009) Oesophageal seal of the novel supralaryngeal airway device I-Gel™ in comparison with the laryngeal mask airways Classic™ and ProSeal™ using a cadaver model. *British Journal of Anaesthesia* **102:**135-139.

Seet E, Rajeev S, Firoz T, et al (2010) Safety and efficacy of laryngeal mask airway Supreme versus laryngeal mask airway ProSeal: a randomized control trial. *European Journal of Anaesthesiology* **27:**602-607.

Smally AJ. (2007) The esophageal-tracheal double-lumen airway: rescue for the difficult airway. *American Association of Nurse Anesthetists Journal* **75:**129-134.

Staudinger T, Brugger S, Watschinger B et al (1993) Emergency intubation with the Combitube®:comparison with the endotracheal airway. *Annals of Emergency Medicine* **22:**1573–1575.

Tam RK, Maloney J, Gaboury I et al (2009) Review of endotracheal intubations by Ottawa Advanced Care Paramedics in Canada. *Prehospital Emergency Care* **13:**311-315.

Tan B, Chen E, Liu E (2010) An evaluation of the Laryngeal Mask Airway Supreme™ in 100 patients. *Anaesthesia and Intensive Care* **38:**550-554.

Tan MG, Chin ER, Kong CS et al (2005) Comparison of the re-usable LMA Classic™ and two single-use laryngeal masks (LMA Unique™ and SoftSeal™) in airway management by novice personnel. *Anaesthesia and Intensive Care* **33:**739-43.

Tanigawa K and A Shigematsu (1998) Choice of airway devices for 12,020 cases of nontraumatic cardiac arrest in Japan. *Prehospital Emergency Care* **2:**96–100.

Timmermann A, Cremer S, Heuer J, et al (2008) Laryngeal Mask LMA Supreme™. Application by medical personnel inexperienced in airway management. *Anaesthesist* **57:**970-5.

Trabold B, Schmidt C, Schneider B et al (2008) Application of the three airway devices during emergency medical training by health care providers – a manikin study. *American Journal of Emergency Medicine* **26**:783-88.

Tumpach EA, Lutes M, Ford D et al (2009) The King LT versus the Combitube: flight crew performance and preference. *Prehospital Emergency Care* **13:**324-328.

Turan A, Kaya G, Koyuncu O et al (2006) Comparison of the laryngeal mask (LMA™) and laryngeal tube LT (LT®) with the new perilaryngeal airway (CobraPLA®) in short surgical procedures. *European Journal of Anaesthesiology* **23:**234–8.

Vaida S (2007) The Esophageal-Tracheal Combitube® and esophageal injuries. *Canadian Journal of Anaesthesiology* **54:**491-492.

Van Zundert A, Al-Shaikh B, Brimacombe J et al (2006) Comparison of three disposable extraglottic airway devices in spontaneously breathing adults: the LMA-Unique™, the Soft Seal Laryngeal Mask, and the Cobra Perilaryngeal Airway. *Anesthesiology* **104:**1165–1169.

Ventola CL (2008) Challenges in evaluating and standardizing medical devices in health care facilities. *Pharmacy and Theraputics* **33:**348-359.

Vézina D, Lessard MR, Bussieres J et al (1998) Complications associated with the use of the Esophageal-Tracheal Combitube. *Canadian Journal of Anaesthesiology* **45:**76–80.

Wang HE, Mann NC, Mears G et al (2011) Out-of-hospital airway management in the United States. *Resuscitation* **82:**378-385.

Wharton NM, Gibbison B, Gabbott DA et al (2008) I-gel insertion by novices in manikins and patients. *Anaesthesia* **63:**991-995.

Wong DT, Yang JJ, Jagannathan N (2012) Brief review: the LMA Supreme™ supraglottic airway. *Canadian Journal of Anaesthesiology* Epub ahead of print.

Young B (2003) The Intubating Laryngeal-Mask Airway may be an ideal device for airway control in the rural trauma patient. *American Journal of Emergency Medicine* **21:**80-85.

Zaballos M, Bastida E, del Castillo T et al (2010) In vitro study of magnetic resonance imaging artifacts of six supraglottic airway devices. *Anaesthesia* **65:**569-572.